

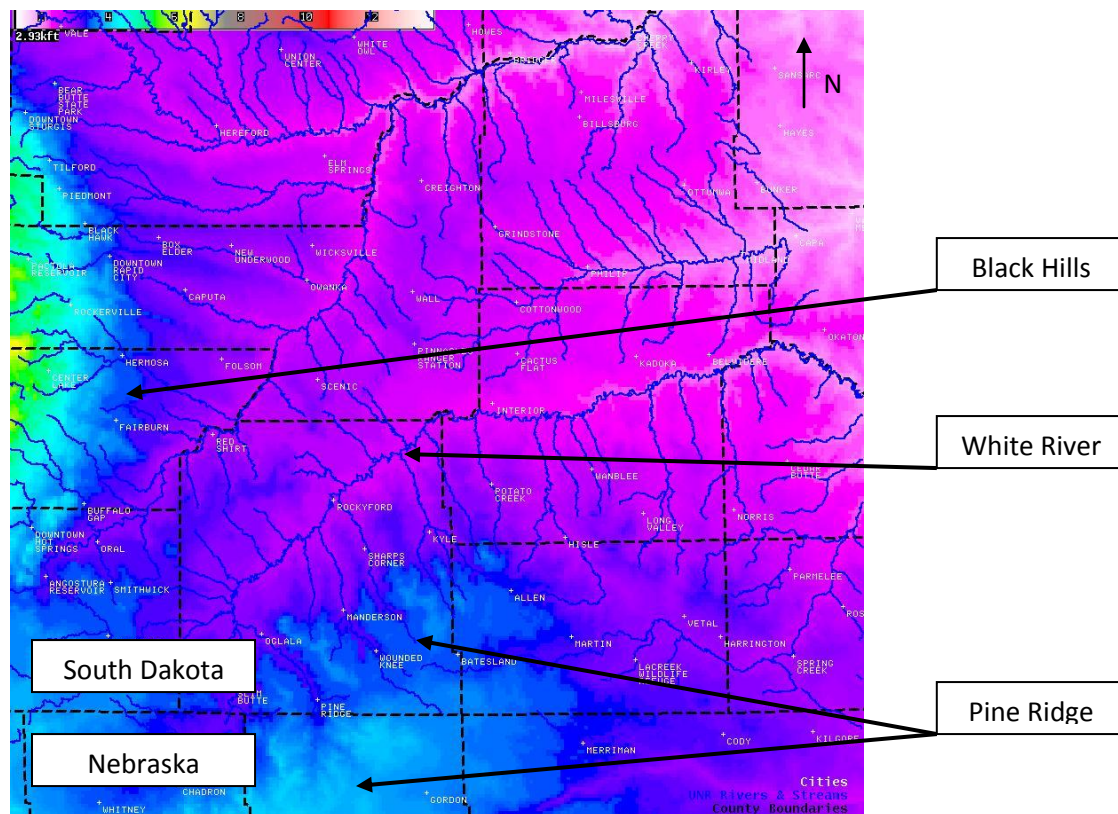
## Darren Van Cleave – WFO UNR - AWOC IC4.3 Microclimates Project

### Overview

Snowfall enhancement near the Pine Ridge area of Shannon, southern Jackson, and western Bennett Counties in South Dakota is a common occurrence when northerly and northwesterly surface flow is present during a winter storm with high Froude numbers. This area of upslope enhancement is often overshadowed by the frequent and more-pronounced upslope of the nearby Black Hills. However, snowfall observations show that the approximately 1,000 feet of elevation change of the Pine Ridge escarpment is still capable of creating notable snowfall gradients depending on low-level wind direction and stability profiles. In addition, under certain stability conditions and northwesterly surface flow, convergence in the lee of the Black Hills can also increase snow totals in the vicinity of the Pine Ridge. This very brief documentation of this microclimatic region will provide a quick summary of the geography and an example of snowfall enhancement.

### Topography

The Pine Ridge is an area of higher terrain oriented southwest to northeast along the western South Dakota and Nebraska border, bounded to the north by the White River and to the south by the Niobrara River. It features a rise in elevation of around 1,000 feet from the drainage of the White River to the north, which happens to be one of the most significant elevation changes along a track due north into North Dakota and southward into the Nebraska Panhandle. Upslope effects in this area can be easily overlooked by forecasters because this terrain change is dwarfed by the 3,000 feet or more of elevation gain in the Black Hills which lie only 70 miles to the northwest, and also because the Pine Ridge Indian Reservation is sparsely populated in comparison to the Black Hills area and thus has fewer observations.

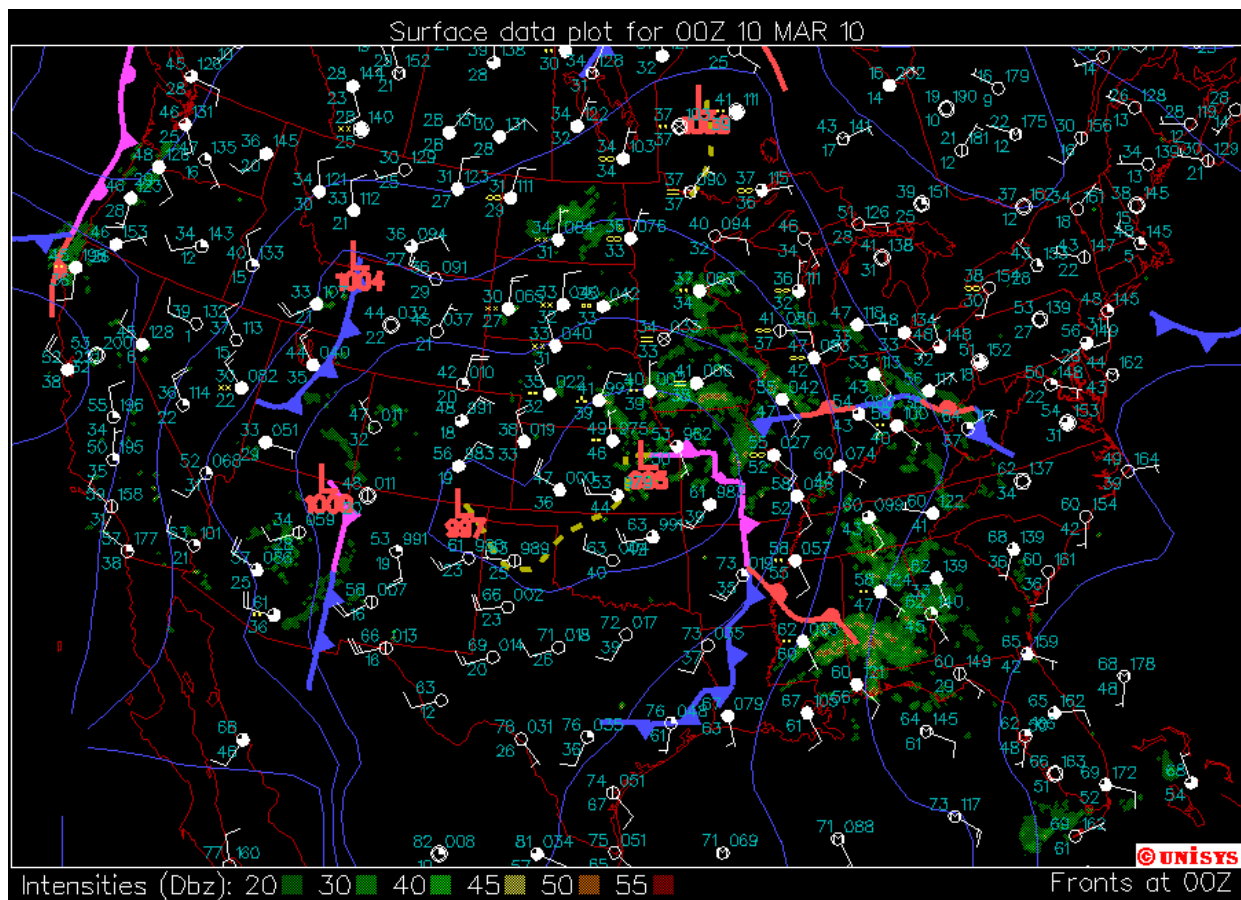


## Upslope Enhancement (and Lee Convergence Enhancement) of Snowfall

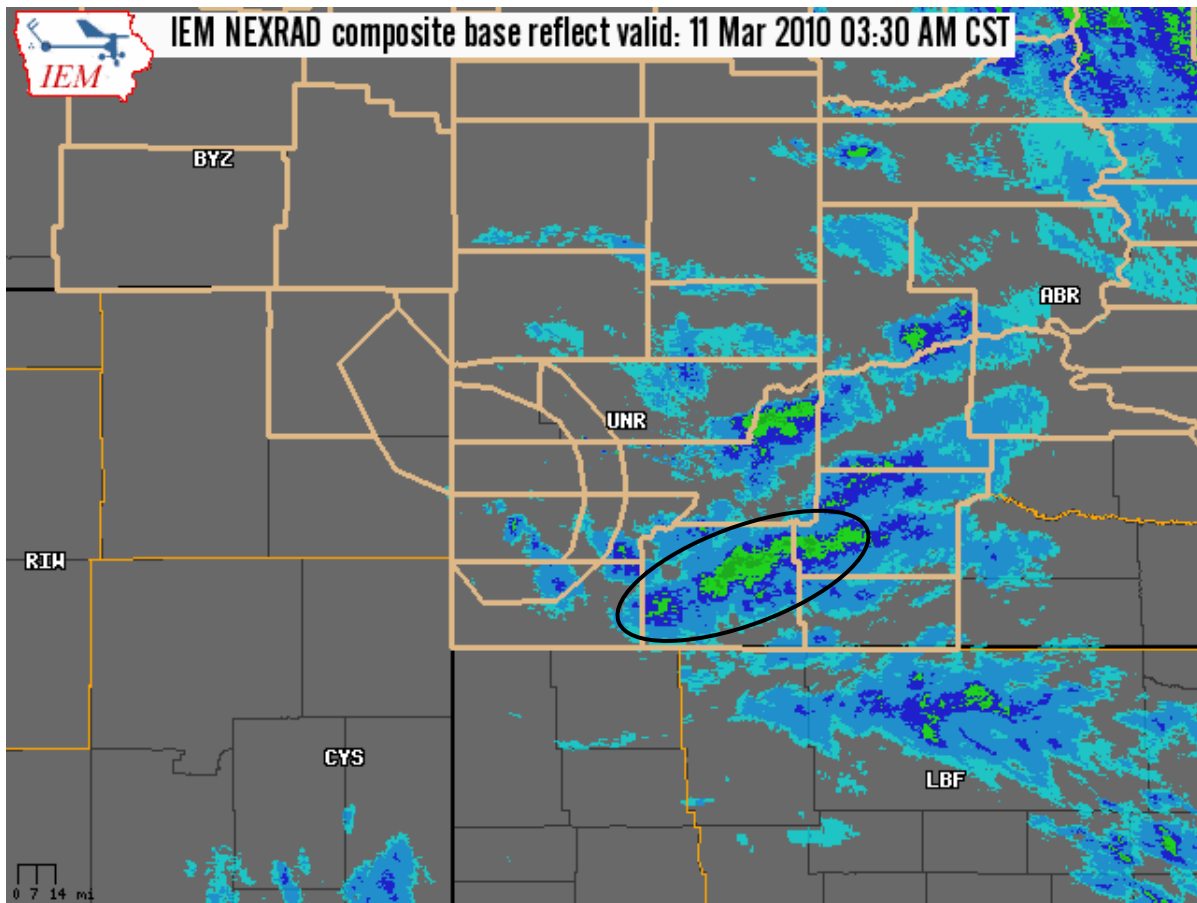
As mentioned, northerly low-level winds lead to upslope flow over the Pine Ridge when stability conditions are favorable for flow crossing a barrier (i.e. when the Froude number is  $\gg 1$ ). However, snowfall can also be enhanced in this area by flow tending to go around barriers (when the Froude number is  $< 1$ ) with northwesterly boundary layer winds because flow in that case would go around the Black Hills and converge in their wake, which happens to be over the Pine Ridge.

### Example Case – March 10-12 2010

This case featured a longwave trough moving into the northern Rockies and an attendant surface low developing to the south and east of the trough base over the central plains. The track of the surface low was such that northerly winds were experienced at the surface in western SD through most of the event (as shown in the plot below, which unfortunately lacks radar coverage for SD), leading to upslope flow over the Pine Ridge region.



The next image is composite base reflectivity centered over western South Dakota. An area of enhanced reflectivity is readily apparent over the northern edge of the Pine Ridge escarpment in this image. A loop of this product reveals that this enhanced reflectivity signature continued for more than 8 hours over approximately the same area as other areas of precipitation wax and wane while moving southward across the radar scan.



This plot below of 24-hour snowfall measurements from NWS cooperative observers clearly shows the higher snowfall amounts in vicinity of the Pine Ridge, with 14 inches reported near Kyle, SD, and 5 inches at Ogallala, SD and Chadron, NE. Meanwhile, measurements outside of this area range from 0.5 to 3 inches.

